LBL-15783
Preprint

Lawrence Berkeley Laboratory
UNIVERSITY OF CALIFORNIA

RECEIVED
LAWRENCE
BERKELEY LABORATORY
MAY 17 1983
LIBRARY AND
DOCUMENTS SECTION

ENERGY & ENVIRONMENT DIVISION

Submitted to the Review of Scientific Instruments

FIELD DATA LOGGER WITH EPROM STORAGE

A.W. Robb and W.W. Nazaroff

March 1983

TWO-WEEK LOAN COPY

This is a Library Circulating Copy which may be borrowed for two weeks. For a personal retention copy, call Tech. Info. Division, Ext. 6782.

ENERGY AND ENVIRONMENT DIVISION

Prepared for the U.S. Department of Energy under Contract DE-AC03-76SF00098

LBL-15783

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

Submitted to
Review of Scientific Instruments

LBL-15783
EEB-Vent 83-4

Field Data Logger with EPROM Storage

A.W. Robb and W.W. Nazaroff

Building Ventilation and Indoor Air Quality Program
Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720

March 1983

This work was supported by the Assistant Secretary for Conservation and Renewable Energy, Office of Building Energy Research and Development, Building Systems Division, and by the Director, Office of Energy Research, Office of Health and Environmental Research, Human Health Assessments Division and Pollutant Characterization and Safety Research Division of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098, and by the Bonneville Power Administration.

ABSTRACT

A data logger using electrically-programmable read-only memory for data storage is described. The storage capacity is sufficient to record measurements from eight instruments at 30-minute intervals for almost ten days. This approach provides a moderately-priced alternative to data loggers using magnetic tape or floppy disks when only modest data storage capacity is needed.

Keywords: data recording, microcomputer applications, instrumentation.

FIELD DATA LOGGER WITH EPROM STORAGE

We designed the data logger described in this note for field monitoring of indoor air pollutants and related parameters. As such, the primary requirements were compact design, simple operation, moderate cost, and a reliable data storage medium which could be shipped from the field. Our requirements for data storage capacity are modest; typically we want to log eight parameters at 30-minute intervals with a week of unattended operation. We decided against purchasing data loggers using floppy disks or magnetic tape cartridges as storage media because of their relatively high cost. Instead, we designed a data logger using electrically-programmable read-only memory (EPROM) as the storage media. The prototype version can monitor 14 analog-voltage inputs, and can store about 3800 measurements in four 2 K x 8-bit EPROMs[1] mounted on an 8 x 11 cm circuit board. It is housed in a cabinet measuring 29 x 33 x 18 cm.

As shown in Figure 1, the data logger is based on an NSC 800 microprocessor,[2] a CMOS version of the Z-80 processor. The program that controls the data logger, written in assembly language, resides in 4 K bytes of EPROM; 4 K bytes of random-access memory are used for program execution. The analog-to-digital converter is coupled to a 16-channel analog multiplexer. Two of the inputs are connected to ground and a reference voltage, respectively; the other 14 are available as monitored inputs. Input voltages may range between -4 to +4 V; the measurement precision is 1 mV.

The circuit board containing the data-storage EPROMs is located behind a door in the front panel. A micro-switch senses the door position: when the door is opened, the data logger halts operation and disconnects power from the EPROM board.

Several front panel switches and a 40-character liquid-crystal display panel constitute the primary user interface. The switches are used to set operating parameters and to select from 16 display pages, each giving some information about the operation of the data logger or the voltages being measured. All data written to the EPROMs is also written to a serial communications port which can, for example, be connected to a printing terminal. A switch can be set to route data only to the serial port, so that the data logger can be used with an external recording device having more storage capacity than the EPROMs.

The data logger reads voltages from the channels being monitored at a rate of about two per second. The user can specify the interval at which a data block is written within the range of 1 to 255 minutes. For each channel the data are recorded in one of four formats: (1) average voltage, (2) instantaneous, i.e. most recent, voltage, (3) unused input (not logged), and (4) integrated change in voltage. This latter type is used for monitoring instruments which count pulses, converting the total to an analog voltage.

Data are written using two bytes per channel plus a one byte checksum per data block. Unique two-byte markers are written to indicate occasions of power failure, door openings, or system starts or stops. The date and time are stored in a six-byte format whenever the system is started or stopped.

Our first application of this data logger is in a study of ^{222}Rn transport from soil through crawl spaces and into houses.[3] Here data from eight instruments measuring radon concentrations and weather parameters are recorded at 30-minute intervals; for this project the storage capacity of the data logger is almost 10 days. Circuit boards containing data are mailed from the field back to our laboratory where they are read by an 8080-based microcomputer system;[4] the data are then transmitted to a more powerful computer for analysis. After the EPROMs are erased, the circuit board is ready to be sent back to the field.

ACKNOWLEDGEMENT

We thank Dr. D. Grimsrud, B. Smith, and W. Fisk for reviewing the manuscript. This work was supported by the Assistant Secretary for Conservation and Renewable Energy, Office of Building Energy Research and Development, Building Systems Division, and by the Director, Office of Energy Research, Office of Health and Environmental Research, Human Health Assessments Division and Pollutant Characterization and Safety Research Division of the U.S. Department of Energy under Contract NO. DE-AC03-76SF00098, and by the Bonneville Power Administration.

REFERENCES AND NOTES

1. EPROMs with 4 K x 8 bit and 8 K x 8 bit capacities are available and becoming less expensive with time. In the latter case the storage capacity of a 4-EPROM board is about eight times less than that of a single-density single-sided eight-inch floppy disk.

2. The system was designed around the NSC 888 Evaluation Board, National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, CA 95051.

3. For background information on indoor radon from soil see A.V. Nero, "Indoor Radiation Exposures from Radon and Its Daughters: A View of the Issue," to be published in Health Physics, 1983; R.C. Bruno, JAPCA, 33, 105 (1983).

4. Intel iSBC 80/20, Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051.

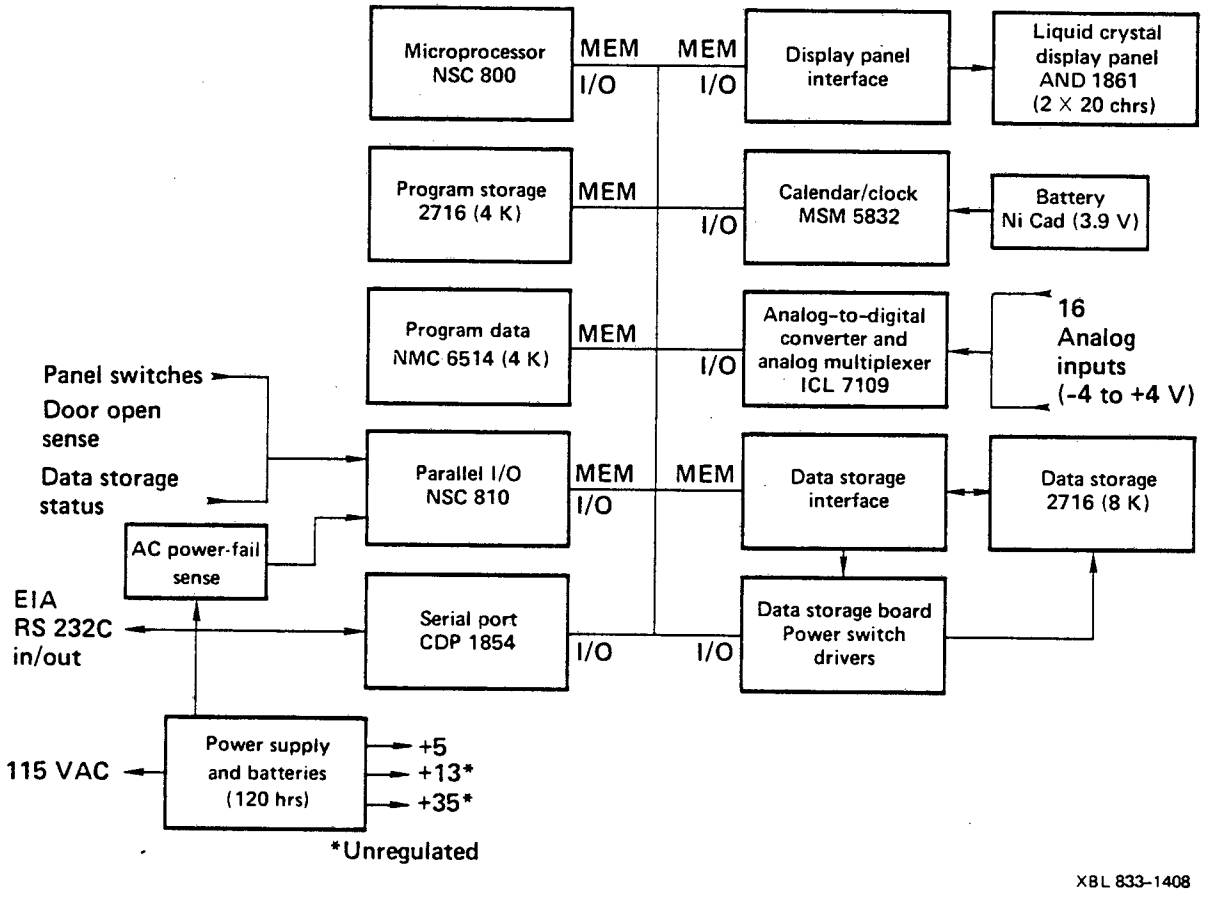

Figure 1. Hardware block diagram of field data logger. "I/O" and "MEM" refer to input/output and memory addressing of the respective circuits.

This report was done with support from the Department of Energy. Any conclusions or opinions expressed in this report represent solely those of the author(s) and not necessarily those of The Regents of the University of California, the Lawrence Berkeley Laboratory or the Department of Energy.

Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U.S. Department of Energy to the exclusion of others that may be suitable.

TECHNICAL INFORMATION DEPARTMENT
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720